Electric fields - Topic Test

A Physics

1. Sketch the fields and equipotential lines round...

(a) 2 isolated positive point charges (2)

(b) 2 oppositely charged parallel plates (2) [4]

2 Define these laws and quantities, giving all formulae and explaining all units

(a) Coulomb's law (2)

(b) Field strength - near a point charge (2)

(c) Field strength - between 2 parallel plates (2)

(d) Potential near a point charge (2)

(e) Work done in moving a charge in a field across a p.d. (2)

Data...

Mass electron = 9.1×10^{-31} kg

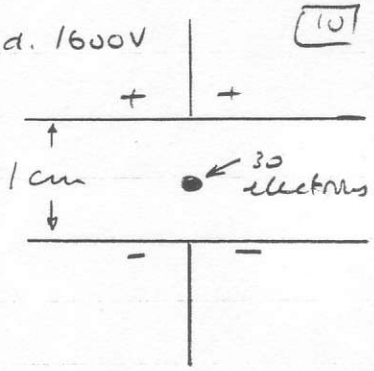
Charge $e = -1.6 \times 10^{-19}$ C

ε_0 space = 8.9×10^{-12} F m^{-1}

$g = 10$ N/kg

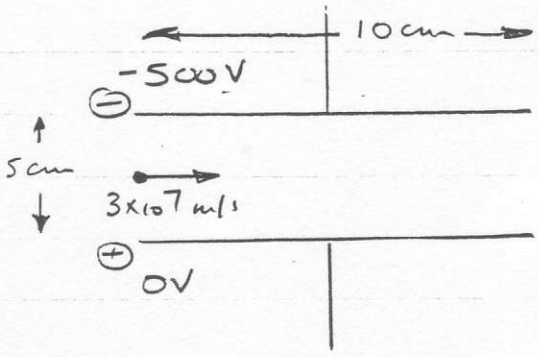
...but don't repeat repeat yourself!

3. A small oil drop is suspended motionless between 2 parallel plates, 1 cm apart, with a p.d. of 1600 V between 'em. If the oil drop is charged with 30 excess electrons, what is its mass? (4) [10]



4 An electron beam is produced in an evacuated TV tube by firing electrons from a filament at −1500 V. If the screen potential is 0V, what is the electrons' speed at the screen? (4)

5. An electron enters the gap between 2 parallel plates, as shown.



(a) Calculate the lateral (sideways) acceleration of the electron (6)

(b) Sketch the path of electron between the plates. (2)

(c) Calculate its velocity when it emerges at the other end (6)

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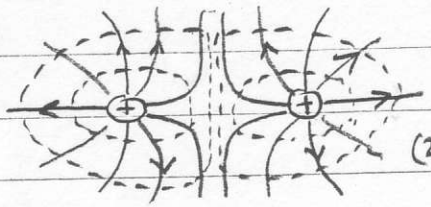
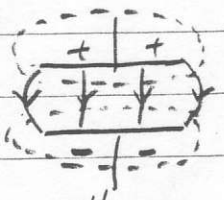
Electric Fields – Test Answers

A Physics

1 (a) 

field – shape + direction ① (b) 

(2) equipot lines – shape ① (2) 4

2 (a) force $F_E = \frac{1}{4\pi\varepsilon_0}\frac{Q_1 Q_2}{d^2}$ — Q_1, Q_2 charges, C; d distance, m; ε_0 permittivity F/m

(b) $E_E = \frac{1}{4\pi\varepsilon_0}\frac{Q_1}{d^2}$ N/C

(c) $E_E = V/d$ p.d. V

(d) $V_E = \frac{1}{4\pi\varepsilon}\frac{Q_1}{d}$ volts, J/C

(e) E or Work = QV. J 10

3. $F_E = QE = \frac{QV}{d}$ ① ① $= 30\times1.6\times10^{-19}\times1600/1\times10^{-2} = \underline{7.68\times10^{-13}}$ N ①

$F_E = mg$ so mass $m = F_E/g = \underline{7.7\times10^{-14}}$ kg ① 4

4 all electrical P.E → KE

QV ① $= \frac{1}{2}mv^2$ ① $= 1.6\times10^{-19}\times1500\,(V) = \underline{2.4\times10^{-16}}$ J ① $= \frac{1}{2}mv^2$

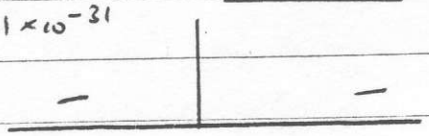
So $v^2 = 2\times2.4\times10^{-16}/9.1\times10^{-31} = 5.27\times10^{14}$

So velocity $v = 22.96\times10^6 = \underline{23\times10^6}$ m/s ① 4

5 (a) Elec. field $E = V/d$ ① $= 500/5\times10^{-2} = \underline{10{,}000}$ V/m ①

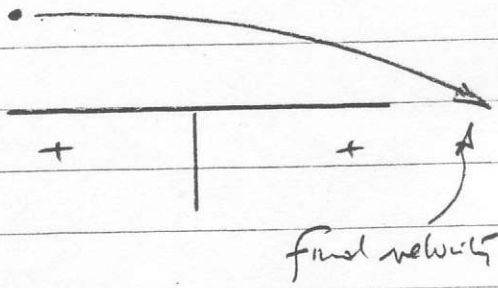
Force on electron $F_E = eE$ ① $= 1.6\times10^{-19}\times10{,}000 = \underline{1.6\times10^{-15}}$ N ①

Sideways acceleration $a = F_E/m$ ① $= \frac{1.6\times10^{-15}}{9.1\times10^{-31}} = \underline{1.76\times10^{15}}$ m/s² ① /6



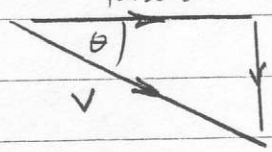
(b) gentle curve ①

down (towards +) ① /2



(c) Find velocity in a meter

$V_{forward} = 3\times10^7$ m/s



$= u + at$ ①

Time between the plates $t = D/V$ ① $= \frac{10\times10^{-2}}{3\times10^7} = \underline{3.33\times10^{-9}}$ s ① $s = vt$

So $V_{sideways} = 0 + 1.76\times10^{15}\times3.3\times10^{-9} = \underline{5.87\times10^6}$ m/s ①

$\tan\theta = V_\downarrow/V_\rightarrow = 5.87\times10^6/3\times10^7 = 0.195 \rightarrow \theta = \underline{11.1°}$ ①

$V_{final} = \sqrt{V_\rightarrow^2 + V_\downarrow^2} = \underline{3.06\times10^7}$ m/s ① at angle $\underline{11°}$ ① /6

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